Smart Hydroponics: IoT and ML-Driven Sustainable Farming

Proposal Document

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Co-Supervised by: Dr. Muhammad Ashraf, Professor, Department of Business Studies

Department of Electrical Engineering
Namal University, Mianwali

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Abstract

The proposed project aims to create a Smart Hydroponics system, leveraging Internet of Things (IoT) and Machine Learning (ML) technologies. By integrating real-time environmental monitoring and data-driven optimization, the system will enhance plant growth and ensure efficient resource utilization. This project addresses key agricultural challenges, contributing to sustainable farming practices aligned with Sustainable Development Goals (SDGs) such as zero hunger, water management, and climate action.

Project problem statement

Traditional farming practices are often resource-intensive, contributing to water wastage, inefficient nutrient use, and susceptibility to environmental conditions. These limitations hinder productivity and sustainability. Additionally, the global population growth demands innovative farming solutions that can ensure food security while minimizing environmental impacts.[1] There is a need for a smart, data-driven system that can monitor and adjust farming conditions in real-time to optimize plant growth and resource usage.

Project description

In Smart Hydroponics project, we will design a hydroponic farming system that integrates IoT sensors to continuously monitor environmental parameters such as temperature, humidity, pH levels, and nutrient concentrations. Machine Learning algorithms will analyse this data, providing real-time insights and control actions to adjust water flow, nutrient levels, and environmental factors to optimize plant growth. This approach will not only improve crop yield and quality but also reduce water and nutrient wastage. The project's innovation lies in its ability to learn and adapt to different plant species' needs over time, making it a scalable solution for sustainable agriculture.

Work distribution

Table 1: Work Distribution

Sr. No	Tasks	Lead By	Followed By
1	Literature Review	Fahim Ur Rehman Shah, Riaz Ud Din	
2	Hydroponic System Design (Implementation phase I)	Riaz Ud Din, Fahim Ur Rehman Shah	
3	Motor and Nutrients Flow Control System Design (Implementation phase II)	Fahim Ur Rehman Shah	Riaz Ud Din
4	IoT Circuit Design (simulation and Implementation)	Riaz Ud Din	Fahim Ur Rehman Shah

5	Microcontroller Coding and configuration of sensors	Riaz Ud Din	Fahim Ur Rehman Shah
6	Testing (Nutrients Flow Control System)	Fahim Ur Rehman Shah	Riaz Ud Din
7	Sensors and Cloud Integration	Fahim Ur Rehman Shah	Riaz Ud Din
8	Data Collection and Preprocessing	Fahim Ur Rehman Shah	Riaz Ud Din
9	Data Cleaning	Riaz Ud Din	Fahim Ur Rehman Shah
10	Model Training and Testing	Riaz Ud Din	Fahim Ur Rehman Shah
11	Integration of IoT and ML Collectively	Fahim Ur Rehman Shah	Riaz Ud Din
12	Final Implementation	Riaz Ud Din	Fahim Ur Rehman Shah
13	Design Poster	Fahim Ur Rehman Shah	Riaz Ud Din
14	Research Paper	Riaz Ud Din	Fahim Ur Rehman Shah
15	Final Presentation and Report	Riaz Ud Din, Fahim Ur Rehman Shah	

Project budget

Table 2: Project Budget

Sr.No	Item	Approximated Price
1	Hydroponic System Structure	15,000
2	Microprocessor	3000
3	NPK, PH, Moisture, Temperature, Electrical Conductivity Sensors	21000
4	Air Pump	1000
5	Water Pump	1500
6	Solenoid Valves	2000
7	Relays Kit	1500
8	Nutrients Solution	5000
9	Power Supply Unit	2500
	Total	**52500**

Resources required from department/ university

- Laboratory equipment for system setup and testing.
- Technical support for hardware procurement from Electrical Workshop.
- Mentorship and guidance from faculty in Electrical Engineering and Business Studies.

Project plan/ timeline

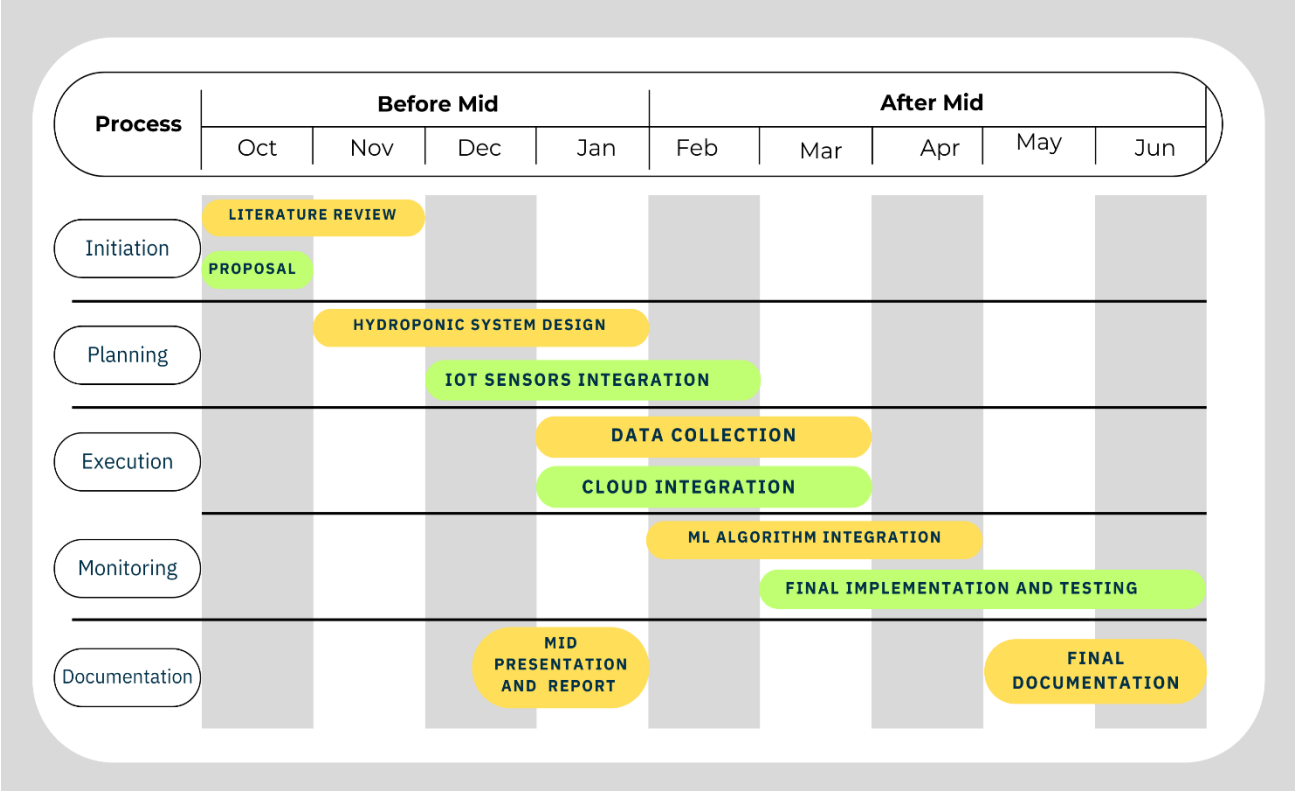

Figure 1:Project Timeline

Project constraints

- **Budget Limitation**: The project relies on affordable components, and unforeseen expenses may hinder progress.
- **Data Availability**: Sufficient training data is needed to optimize the Machine Learning models effectively, requiring significant time for data collection.
- **Technical Challenges**: Integration of hardware with software, and ensuring the sensors work in real-time under varying environmental conditions may pose challenges.

Project scope

The project will focus on medium-scale hydroponic setups with a high level of automation. The scope includes building a prototype system capable of monitoring and optimizing the growth of plants. Future iterations of the project could scale to larger farms or implement more advanced features, such as predictive growth analytics.

Project deliverables

- A fully functional Smart Hydroponics system.
- Machine Learning model for optimizing plant growth based on collected data.

- Project report detailing the system design, implementation, and results.
- Recommendations for future improvements and scalability.

References

[1] United Nations for Food and Agriculture Organization, “How to Feed the World in 2050,”2018. Available online: https://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf.

Project Proposal Summary

<table>
<tr><th colspan="8">Department of Electrical Engineering</th></tr>
<tr><th>Group ID</th><th>Group Members</th><th>University Roll#</th><th>Supervisor Name</th><th>Project Title</th><th>Evaluation Status</th></tr>
<tr><td rowspan="3"></td><td>Student 1</td><td>NIM-BSEE-2021-24</td><td rowspan="3">Dr. Ahmed Salim</td><td rowspan="3">Smart Hydroponics: IoT and ML-Driven Sustainable Farming</td><td rowspan="3"></td></tr>
<tr><td>Student 2</td><td>NIM-BSEE-2021-36</td></tr>
<tr><td>Student 3</td><td>NIM-BSMATH-2021-33</td></tr>
<tr><td rowspan="4">Summary:</td><td colspan="5">What:
Designing an IoT and ML-Driven Hydroponic System.</td></tr>
<tr><td colspan="5">Why:
To prevent resources (water, land, nutrients) wastage, enhance the performance and efficiency of hydroponic farming, and fulfill global food demand.</td></tr>
<tr><td colspan="5">How:
By integrating IoT sensors and ML algorithms to monitor environmental parameters, adjust water flow and nutrient levels to optimize resources and maximize plants growth.</td></tr>
<tr><td colspan="5">Expected Outcome:
Optimizes gardening by monitoring environmental conditions for enhanced plant growth.</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td rowspan="6">Methodology</td><td colspan="2">By Supervisor/Student</td><td>Suggestion 1</td><td>Suggestion 2</td><td>Suggestion 3</td><td>Suggestion 4</td><td rowspan="6"></td></tr>
<tr><td>Input of the System (Data Source)</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Application Development Environment</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Hardware Architecture and System</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Application Algorithm</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Front-end Infographics</td><td></td><td></td><td></td><td></td><td></td></tr>
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Outcome Deliverables	**By Supervisor/Student**		Suggestion 1	Suggestion 2	Suggestion 3	Suggestions 4
		Deliverable 1				
		Deliverable 2				
		Deliverable 3				
		Deliverable 4				
Business Model (If any)	Market, Commercialization Plan Financial Plan SWOT analysis ROI					
Industrial Linkages (If Any)	Support Letter Commercialization Financial Support (If any)					
Targets and Objectives						